William T. Haslam
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LECTURES

ON

GENERAL PATHOLOGY

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LECTURES

ON

SURGICAL PATHOLOGY

DELIVERED AT THE

ROYAL COLLEGE OF SURGEONS OF ENGLAND

BY

SIR JAMES PAGET, BART.

F.R.S., D.C.L. OXON., LL.D. CANTAB.

SERJEANT-SURGEON EXTRAORDINARY TO HER MAJESTY THE QUEEN
SURGEON TO H.R.H. THE PRINCE OF WALES
CONSULTING SURGEON TO ST. BARTHOLOMEW'S HOSPITAL

REVISED AND EDITED BY

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PROFESSOR OF ANATOMY IN THE UNIVERSITY OF EDINBURGH

FOURTH EDITION

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PREFACE

TO

THE FIRST EDITION.

NEARLY ALL the Lectures in these volumes were delivered at the Royal College of Surgeons, during the six years, from 1847 to 1852, in which I held the office of Professor of Anatomy and Surgery to the College. So many listened favourably to them, that I venture to hope I am not wrong in thus enabling many more to read them. But, in offering them to this larger class, some explanation of their scope and plan seems necessary.

The circumstances of my election to the professorship indicated the Pathological Museum of the College as the appropriate subject of the Lectures; and the first portion of the Museum, devoted to the illustration of General Pathology, seemed to offer the best plan by which knowledge acquired in a long study of the whole collection might be communicated.

The modes were many in which such a subject might be treated in lectures; but, as circumstances had decided the subject, it seemed well to let them determine, also, the method, and to adopt that which was most natural to one engaged in the simultaneous practice of surgery and teaching of physiology. Thus guided, I designed to give lectures which might illustrate the general pathology of the principal surgical diseases, in conformity with the larger and more exact doctrines of physiology;

and the plan seemed the more reasonable, because it was in accordance with the constant design of the great founder of the Museum.

The Museum limited, while it indicated, the subjects of the Lectures. They were, therefore, not constructed to form a system of surgical pathology; several subjects, which might fill considerable places in such a system, were scarcely alluded to in them; and, although I have added some Lectures, which could not be conveniently included in any of the courses, yet I have not gone beyond the range of such pathology as a Museum may illustrate.

The wood-engravings are, for the most part, copied from the same specimens and drawings as were the diagrams used in the Lectures; and I wish them to be regarded as intended for only the same purpose as such diagrams may serve;—viz. that of assisting the more difficult parts of the descriptions of the objects to which they refer.

I have endeavoured to make the Lectures less incomplete, and more correct, by the aid of numerous facts ascertained since they were delivered, and have added to them many things which time, or their inaptness for oral delivery, obliged me to omit. Among these are the references to specimens and illustrations; as well as to numerous authors who could not, in speaking, be conveniently quoted, but whom I am now glad to acknowledge as instructors. And I will here offer my thanks to some, to whom my debts are more than would be expressed, even by referring to all the occasions on which their works have aided me in the composition of the Lectures. Such acknowledgments are due, especially, to Mr. Lawrence, Mr. Stanley, Professor Owen, and Dr. Carpenter, from whom, during many years of valued friendship, I have derived, at every interview, either knowledge, or guidance in observing and in thinking. I am deeply obliged, also, to all my colleagues on the staff of St. Bartholomew's, from whom the constant help that I receive adds daily to the debt of

gratitude incurred during my pupilage. And there are many friends, besides, to whom it is my happiness to be indebted for knowledge used in these Lectures, and whom I thank collectively, not because I owe them little, but because I cannot name them all, and cannot thank some without appearing ungrateful to the rest.

I desire, in conclusion, to express my acknowledgments to the Members of the Council of the College, both for the repeated honour they conferred on me by so often electing me to the Professorship, and for the kindness with which many of them devoted their valuable time to attendance at the Lectures. The encouragement they thus afforded me makes me hope, that the labour with which I strive to justify their choice may have some success in the promotion of scientific surgery.

JAMES PAGET.

May 30, 1853.

PREFACE

TO

THE SECOND EDITION.

WHEN THE TIME CAME for preparing a Second Edition of these Lectures, I was anxious that they should be revised with all the light of the knowledge of Pathology acquired since their publication. But although I had collected some materials for this purpose, yet a thorough revision of the whole subject was a task for which I felt unfit. For in the passage of nine years, I had been carried into the active practice of my profession; and, at their end, had no sufficient time for either studying or thinking carefully about the many facts, and probabilities, and guesses at truth which had been added to Pathology. I was, therefore, glad to be able to commit the work of revision to my friend and former pupil, Mr. TURNER, whom I know to be not only very conversant with the progress of medical science, but able to test others' observations by his own. It is not for me to say how well he has done the work, for I have so worked with him as to be equally with him responsible.

May 1, 1863.

PREFACE

TO

THE THIRD EDITION.

For the present Edition of my Lectures, the last Edition has been carefully revised by both Professor Turner and myself: by him from the Pathological point of view, by me from the Clinical. Many parts have been re-written, and several new figures have been added. The result will be, I hope, that, whether for doctrine or for practice, the Lectures will be deemed better than they were.

May 2, 1870.

NOTE

TO

THE FOURTH EDITION.

An unexpected demand for copies of the Third Edition has led to the necessity of printing a Fourth before there could be time for a complete revision. This Edition is, therefore, only a careful reprint of the last.

TITLES OF THE LECTURES.

LIST OF ILLUSTRATIONS.

LECTURES

ON

SURGICAL PATHOLOGY.

LECTURE I.

NUTRITION—ITS NATURE, PURPOSE, AND CONDITIONS.

MR. PRESIDENT AND GENTLEMEN,—I believe that I owe the honour of being elected Professor of Anatomy and Surgery to the College, chiefly, to my having been long engaged in the study of the pathological department of the Museum, while arranging and describing it, under the superintendence of Mr. Stanley, for the new Catalogue. I may, therefore, fairly suppose it to be the wish of the Council that, as the Museum is open to the examination of the members and pupils of the College, and of men of scientific pursuit, so should be the knowledge and the opinions which it has supplied or suggested to those who have had occasion to study it most deeply. For, indeed, to what thus grows out of the study of the Museum, the College has, in some measure, the right which the proprietor has to the produce of the cultivated soil. And when, through a long time past, your most learned Hunterian Professor Owen has every year brought in, from every source, so large a store of deep and wide-extending knowledge, of sagacious interpretation, and acute suggestion of the ways of Nature, I scarcely wonder that some return should be looked for from an inferior labourer in the field.

The subjects on which I shall first beg your favourable hearing are those to the general illustration of which the first two series of preparations in the Pathological Museum are devoted—namely, hypertrophy and atrophy; the simple excess, and the simple deficiency, of nutrition in parts. But let me previously speak of the healthy nutrition of the

tissues, and, herein especially, of the formative process which maintains them by assimilation.

In the natural course of healthy life, the formative process manifests itself in three modes, which, though they bear different names, and are sometimes described as if they were wholly different things, yet, probably, are only three expressions of one law, three effects of the same force operating in different conditions. The three, enumerating them in the order of their time, are development, growth, and assimilation or maintenance. To these succeeds degeneration, or decay, as naturally, but probably through a deficiency in the normal formative process.

By development we mean generally the process by which a tissue or organ is first formed; or by which one, as yet imperfectly formed, is so changed in shape or composition as to be fitted for a higher function, or, finally, is advanced to the state in which it exists in the most perfect condition of the species.

We must carefully distinguish development from mere increase; it is the acquiring not of greater bulk, but of new forms and structures, which are adapted to higher conditions of existence. For example, when, in the embryo, groups of primordial nucleated cells are converted into the tissues characteristic of the perfect structure of the part in which the conversion is effected, there is something more than an increase in size, there is a change of texture, and an acquirement of power, adapted to a higher state of existence; these constitute development. So, when from the simple cavity and walls of the embryonic digestive system, the stomach, intestines, liver, pancreas, and other organs are produced, these are developed, there is increase, but, at the same time, something more than mere increase.

The distinction between development and increase, or growth, is well shown in this—that, sometimes, even in instances in which they usually concur, the one proceeds without the other. I might quote many examples of this. I will choose one or two which, at the same time may illustrate some other striking facts.

Thus, for examples in which development was checked and growth proceeded even beyond its normal limits, we may examine some of the numerous malformed hearts in the Museum. One among them presents only a single cavity; no partition has been developed between its auricles or its ventricles; it is, in respect of its development, like the heart of a fœtus in the second month; but though its development was checked thus early, its growth continued, and it has more than the

average size of the hearts of children of the same age. In another, development was arrested at a later period, when the septum of the ventricles was incompletely formed; the patient lived eleven years after birth; the development made no further progress, but the growth passed its ordinary bounds.

And, once more, for instances in which the development was normal and growth abnormal, you may examine such skeletons as those of O'Byrne the giant, and of Madlle. Cracami the dwarf, in the Physiological Museum. The one is eight feet high, the other only twenty inches; but if you compare these with the model skeletons which stand beside them, you will not find in the one a defect, or in the other an excess, of development; the dwarf has not less than all the characteristic human forms, the giant has no more; but the one is defective, the other is excessive, in its bulk; the growth alone has been erroneous in both.

It is then, in the change to a higher state of form or composition that development differs from growth, the second mode of the formative process. In mere growth no change of form or composition occurs; parts only increase in weight, and usually, in size. In growth, there is an addition of quantity, but no improvement in the quality of a part; the power of the growing part increases with the growth, but is only more o fthe same power. So, in the attainment of manhood, the heart of the boy having all its necessary parts, and all well formed, acquires perfection by acquiring greater bulk, and, therewith, greater power.

Lastly, in the formative process, as it is normally manifested in the adult, *i.e.* in ordinary assimilation or maintenance, parts only preserve their *status*. No perceptible change of size or weight ensues, no change of form or composition; sameness is maintained through the regular formation of new parts in the place of those which, in the ordinary course of life, are impaired, or die.

Such are the methods of the formative process in the healthy nutrition of organs. I shall have to show in future lectures that some of the terms just used are in a measure conventional and arbitrary; that some instances of what we call development, *e.g.* that of cartilage into bone, are not in every sense justly so named; and that the sameness, which is maintained in the adult body, fades into a gradual degeneration. But, for the present, the terms that I have used may suffice. It is convenient also to think of the three methods of formation, as if each might be separately manifested; yet, probably, they are often concurrent; the maintenance of some, or of many whole

organs being achieved only by the constant development and growth of new elemental structures in the place of those that are worn out.

Now, for the elucidation of this maintenance of parts by the constant mutation of their elements, let me speak—

1*st*, Of the sources of impairment, or if I may so say, of the wear and tear, to which every part of the body appears to be subject.

2*dly*, Of the conditions necessary for the healthy state of the process of nutrition by which the results of the wear and tear are repaired.

3*dly*, Of the formative process itself.

First, then, the deterioration of the body may be traced to two principal sources; namely, the wearing out of parts by exercise, and the natural deterioration or death of the elemental structures of every part or organ, independent of the decay or death of the whole body, after a certain period of existence.

From the first of these, the wearing-out of parts by exercise, it is probable that no tissue or part enjoys immunity. For although, in all the passive apparatus of the body—the joints, bones, ligaments, elastic vessels, and the like—much of the beauty of their construction consists in the means applied to diminish the effects of the friction, and the various pressures and stretchings to which they are subject, yet, in enduring these at all, they must be impaired, and, in the course of years, must need renewal. In these parts, undoubtedly, the waste by exercise is much less than that of the more active organs, such as the muscles and the nervous system. With regard to the muscles, it is clear that chemical decomposition and consumption of their substance, which bear a relation to the amount of work they perform, attend their continued action. Such action is always followed by the increased discharge of carbonic acid and water. The researches of Helmholtz[1] and Ranke show that the muscles themselves, after long-repeated contractions, are changed in chemical composition; those of G. von Liebig[2] have detected and measured the formation of carbonic acid in them during similar contractions. Du Bois Reymond has pointed out[3] that lactic acid is formed during the contraction of the muscles, and Ludwig and Schmidt[4] have proved that muscles in action remove more oxygen from the blood circulating through them than muscles at rest.

[1] Müller's *Archiv*, 1845, p. 72.
[2] *Ibid.* 1850, p. 393.
[3] *Monat's Bericht der Akad. der Wissen. zu Berlin*, 1860, p. 288.
[4] *Centralblatt*, No. 32, 1868.

We have nearly similar evidence of the impairment of the nervous system by prolonged exertion of its functions. The experiments of Ranke[1] would seem to prove that chemical changes, which use up a portion of nerve-tissue occur within it during the continuance of nervous work, and the abundance of phosphates occasionally discharged with the urine, after great mental exertion, shows that the various acts of the mind impair the brain through which they are manifested. To this point tend, also, the researches of Dr. Bence Jones,[2] who has shown that the excretion by the kidneys of a large quantity of phosphatic salts is usual in acute inflammation of the brain. And to this conclusion, that mental exercise, whether perceptive or active, impairs the structure of the brain, we might be led by our sensations and by our knowledge of the nature of the Mind. For to the principal, the immaterial thing, we cannot ascribe a weariness; it cannot be obnoxious to waste or to decay; mental fatigue is only what the Mind feels of an impaired state of the brain, and the recovery from what we call a weary mind is the restoration, not of the Mind itself, but of the organs which connect it with the external world, and in which, during tranquil sleep, the reparative nutrition goes on undisturbed.

It is, further, probable that no part of the body is exempt from the second source of impairment; that namely, which consists in the natural death or deterioration of the parts (independent of the death or decay of the whole body) after a certain period of their life. It may be proved, partly by demonstration, and partly by analogy, that each integral or elemental part of the body is formed for a certain natural period of existence in the ordinary conditions of active life, at the end of which period, if not previously destroyed by outward force or exercise, it degenerates and is absorbed, or dies and is cast out; needing, in either case, to be replaced for the maintenance of health.[3]

The simplest examples that I can adduce of this are in the hair and teeth; and in the process which I shall describe and illustrate with the annexed diagram, we seem to have an image in which are plainly

[1] *Die Lebensbedingungen der Nerven*, and *Journal of Anatomy and Physiology*, Nov. 1868.

[2] *Med.-Chir. Trans.* xxx. p. 20.

[3] Hunter (*Works*, iii. p. 495) and Treviranus (*Biologie*, b. iii. 482) may be thought to have had some insight into this important law; but the merit of having first maintained in terms nearly similar to the above, and as more than an hypothesis, that 'each part of the organism has an individual life of its own,' and '*a* limited period of existence,' belongs to Dr. Carpenter.—*Principles of Human Physiology*, 3d ed. p. 623

marked, though, as it were, in rough outline, all the great features of the process by which certain tissues are maintained.

An eyelash which naturally falls, or which can be drawn out without pain, is one that has lived its natural time, and has died, and been separated from the living parts. In its bulb such an one will be found very different from those that are still living in any period of their age. In the early period of the growth of a dark eyelash, we find its outer end almost uniformly dark, marked only with darker short linear streaks, and exhibiting no distinction of cortical and medullary substance. Not far from its end, however, this distinction is plainly marked; dark as the cortical part may be, the medullary appears like an interior cylinder

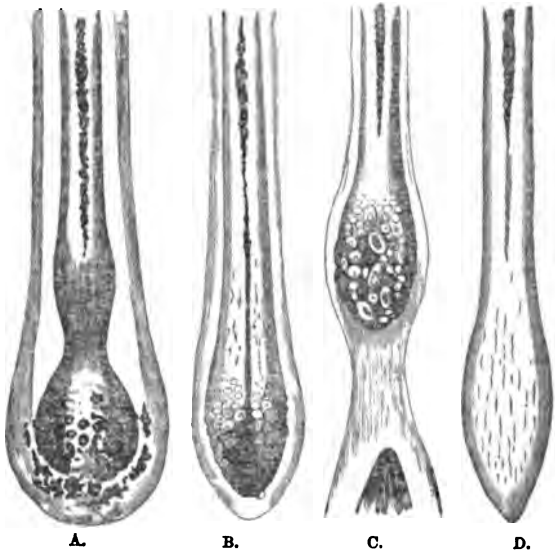

Fig. 1.

of much darker granular substance: and in a young hair this condition is continued down to its deepest part, where it enlarges to form the bulb. (Fig. 1, A.) Now this enlargement, which is of nearly cup-like form, appears to depend on the accumulation of round and plump nucleated cells, which, according to their position, are either, by narrowing and elongation, to form the dry fibro-cells of the outer part of the growing and further protruding shaft, or are to be transformed into the air-holding cells of the medullary portion. At this time of most active growth, both cells and nuclei contain abundant pigment-matter, and the whole bulb looks nearly black. The sources of the material out

of which the cells form themselves are, at least, two—namely, the inner surface of the sheath, or capsule, which envelopes the hair, and the surface of the vascular pulp, which fits in a conical cavity in the bottom of the hair-bulb.

Such is the state of parts so long as the growing hair is all dark. But, as it approaches the end of its existence, it seems to give tokens of advancing age, by becoming grey. (Fig. 1, B, C.) Instead of the almost sudden enlargement at its bulb, the hair only swells a little, and then tapers nearly to a point; the conical cavity in its base is contracted, and hardly demonstrable, and the cells produced on the inner surface of the capsule contain no particle of pigment. Still, for some time it continues thus to live and grow, and we find that the vigour of the conical pulp lasts rather longer than that of the sheath or capsule; for it continues to produce pigment-matter some time after the cortical substance of the hair has been entirely white, and it is still distinct, because of the pigment-cells covering its surface.

At length the pulp can be no longer discerned, and uncoloured cells alone are produced, and maintain the latest growth of the hair. With these it appears to grow yet some further distance, for we see traces of their elongation into fibres or fibro-cells, in lines running from the inner surface of the capsule inwards and along the surface of the hair; and we can always observe that the dark column of medullary air-containing substance ceases at some distance above the lower end of the contracted hair-bulb. (Fig. 1, C, D.)

The end of all is the complete closure of the conical cavity in which the hair-pulp was lodged, the cessation of the production of new cells, and the consequent detachment of the hair as a dead part, which now falls by the first accident—falls sometimes quite bare and smooth on the whole surface of its white bulb, but sometimes bringing with it a layer of cells detached from the inner surface of the capsule. (Fig. 1, D.)

Such is the life of a hair, and such its death; which death, you see, is natural, spontaneous, independent of exercise, or of any mechanical external force, the natural termination of a certain period of life. Yet, before it dies, provision is made for its successor; for when its growth is failing, you often find, just below the base of the old hair, a dark spot, the germ or young pulp of the new one; it is covered with cells containing pigment, and often connected by a series of pigment-cells with the old pulp or capsule. (Fig. 1, C.) And this appears to be produced by an increase in the growth of the cells at the bottom of the hair

follicle, which cells Kölliker's observations have shown to be derived partly from the soft round cells of the hair-bulb, and partly from the adjacent outer-root sheath. By the subsequent elongation and differentiation of these cells the new hair is formed.

I believe that we may assume an intimate analogy between the process of successive life and death, which is here shown, and that which is believed to maintain the ordinary nutrition of a part. It may be objected, indeed, that the death and casting-out of the hair cannot be imitated in internal parts; but we are not without an example in which the absorption of a worn-out internal particle is exactly imitated in larger organs at the end of their appointed period of life. I adduce the instance of the deciduous or milk-teeth.

We trace each of these developed from its germ; then each, having gained its due perfection, retains for a time its perfect state, and still lives, though it does not grow. But at length, as the new tooth comes, the deciduous tooth dies, coincidently, not consequently; or rather, the crown of the old tooth dies, and is cast out like the dead hair; while its fang, and the vascular and nervous pulp, degenerate, and are absorbed. It is here especially to be observed that the degeneration is accompanied by some spontaneous transformation of the fang, for it could not be absorbed unless it were first so changed as to be soluble. And it is degeneration, not death, which precedes its removal; for when a tooth-fang really dies, as that of the second tooth does in old age, then it is not absorbed, but is cast out entire, as a dead part. Such is the process of nutrition in these organic textures which are complex both in structure and composition. For the absorption is not confined to the fang, but includes the tooth-pulp, a structure which is well supplied both with bloodvessels and nerves.

Nor are these the only instances that might be adduced. We see the like development, persistence for a time in the perfect state, death, and discharge, in all the varieties of cuticles; and in the epidermis we have, as in the teeth, an evidence of chemical change in the old cells, in the very different influence which acetic acid and potash exercise on them and on the younger cells, making these transparent, but leaving those scarcely changed.

These things, then, seem to show that the ordinary course of these elementary organs, after the attainment of their perfect state by development and growth, is to remain in that state for a time; then, independently of the death or decay of the whole body, and, at least in a great measure, independently of its own exercise or exposure to exter-

nal violence, to die or to degenerate; and then, being cast out or absorbed, to make way for their successors. But though a bodily removal and replacement of such structures as the hair, teeth, and epithelium cells undoubtedly take place, it cannot be said that in the whole of the fully-formed tissues so complete a casting-out or absorption of the textures takes place in the ordinary course of their nutrition. For in the osseous, nervous, and muscular tissues, for example, the nutritive changes are undoubtedly molecular. The structure remains, though the materials which compose it are renewed.

It appears, moreover, very probable, that the length of life which each part is to enjoy is fixed and determinate, though, of course, in some degree, subject to accidents, which may shorten it, as sickness may prevent death through mere old age; and subject to the expenditure of life in the exercise of function. I do not mean that we can assign, as it is popularly supposed we can, the time that all our parts will last; nor is it likely that all parts are made to last an equal time, and then to be changed. The bones, for instance, when once completely formed, probably last longer than the muscles and other softer tissues. But when we see that the life of certain parts is of determined length, whether they be used or not, we may assume, from analogy, the same of nearly all.

For instance, the deciduous human teeth have an appointed duration of life; not, indeed, exactly the same in all persons, yet, on the whole, fixed and determinate. So have the deciduous teeth of other animals. And in all those numerous instances of periodical moulting, of shedding of the antlers, of the entire desquamation of serpents, and of the change of plumage in birds, and of the hair in mammalia; what means all this, but that these organs live their severally appointed times, degenerate, die, are cast away, and in due time are replaced by others; which in their turn are to be developed to perfection, to live their life in the mature state, and to be cast off? We may discern the same laws of life in some elementary structures; for example, in the blood-corpuscles, of which a first set, formed from embryo-cells, disappears at a certain period in the life of the embryo, being replaced and superseded by a second set formed, probably, from lymph—and chyle—corpuscles. And in these, also, we may see an example of the length of life of elemental parts being determined, in some measure, by their activity in function; for if the development of the tadpole be retarded, by keeping it in a cold, dark, place, and if, in this condition, the function of the first set of blood corpuscles be slowly and imperfectly discharged, they

will remain unchanged for even many weeks longer than usual; their individual life will be thus prolonged, and the development of the corpuscles of the second set will be, for the same time, postponed.[1]

The force of these facts is increased by the consideration of the exact analogy, the almost identity, of the processes of secretion and nutrition; for in no instance is the fact of this limited life of individual parts more clearly shown than in the gland cells, by which periodical secretions are elaborated. The connecting link between such gland-cells and the most highly organised parts as well as a manifest instance of determinate length of life and natural death, is found in the history of the ova. These attain their maturity in fixed successive periods of days; they are separated (as the materials of several secretions are) while yet living, and with a marvellous capacity of development, if only they be impregnated during the few days of life that remain to them after separation; but if these days pass, and impregnation is not effected, they die, and are cast out as impotent as the merest epithelial cell.[2]

Now from these cases it is not by a far-fetched analogy that we assume the like mortality in all other tissues, and that this is the principal source of impairment, and of change for the worse, which every part of the body has within itself, even in the most perfect state, and in the conditions most favourable to life. And I may anticipate a future subject of consideration, by saying that the application of these truths is of some importance in practical pathology; inasmuch as the results of this degeneration of parts, at the close of their natural term of life, may be mingled with the effects of all the morbid processes by which the natural nutrition of a part is hindered or perverted. Hence, at least in part, the long-continuing or permanent loss of power in an organ (say a muscle) which has been disused, or has been the seat of inflammation. This loss is not wholly due to a primary disease of the fibre; in part, it is because the inflammatory process and the organisation of the morbid products exclude the ordinary process of nutrition; and the muscular fibres, which now, in the ordinary course of life, degenerate, are not replaced, or are imperfectly repaired.

[1] Kirke's *Physiology*, pp. 65 and 290, 1st ed.

[2] The adjustment of the organic processes according to laws of time has been more fully illustrated by the author in a discourse 'On the Chronometry of Life,' delivered at the Royal Institution, April 8, 1859, an abstract of which appeared in the Journal of their Proceedings. The subject has also been considered in the Croonian Lecture for 1857 (*Proc. Roy. Soc. Lond.*), to which reference may be made for a discussion of the phenomena of nutrition, in the rhythmically acting muscles, heart, diaphragm, etc.

Of the results of these natural and unrepaired degenerations of tissues I shall speak more hereafter. Let me now consider the conditions under which the repair of parts thus deteriorated is effected; for it is against the effects of these natural deteriorations that the process of nutrition in the adult is chiefly directed; and it appears to be by the disturbance or removal of certain necessary conditions, more often than by any suspension or perversion of itself, that error is engendered in the process of formation. And, in speaking of these conditions of healthy nutrition, I shall take leave occasionally to diverge, even very far, into the consideration of certain points of interest in the general physiology of the process.

Doubtless the conditions necessary to the normal nutrition of parts are very many; but the chief of them are these four:—

1. A right state and composition of the blood or other nutritive material.
2. A regular and not far distant supply of such blood.
3. (At least in most cases) a certain influence of the nervous system.
4. A natural state of the part to be maintained.

And, first of the right state of the blood, I may observe that I use the expression 'right state' rather than 'purity,' because, if the latter be used, it seems to imply that there is some standard of composition to which all blood might be referred, and the attainment of which is essential to health; whereas the truth seems rather to be, that, from birth onwards, the blood and tissues of each creature are adapted to one another, and to the necessary external circumstances of life, and that the maintenance of health depends on the maintenance and continual re-adjustment of the peculiarities on which this exact adaptation depends.

The necessity for this right or appropriate state of the blood, as a condition of healthy nutrition, involves of course the necessity for the due performance of the blood-making and blood-purifying functions; it requires healthy digestion, healthy respiration, healthy excretion. Any one of these being disturbed, the formative process in a part, or in the whole body, may be faulty, for want of the appropriate material. But, important as these are, we must not let the consideration of them lead us to forget that there is something in the blood itself, which is at least as essential to the continuance of its right and healthy state as these are, and which is, indeed, often occupied in correcting the errors to which these, more than itself, are subject; I mean the power of assimilation

or maintenance which the blood possesses, in and for itself, as perfectly and at least as independently as any of the tissues. By this it is, that notwithstanding the diversity of materials put into the blood, and the diversity of conditions in which the functions ministering to its formation are discharged, yet the blood throughout life retains, in each person, certain characters as peculiar as those of his outer features for the continual renewal of which it provides appropriate materials. And by this assimilative power of the blood it is that the tissues are continually guarded; for by it many noxious substances introduced into the blood are changed and made harmless before they come to the tissues; nor can any substance, introduced from without, produce disease in an organ, unless it be such an one as can escape the assimilative and excretory power of the blood itself.

In this maintenance is the chief manifestation of the life of the adult blood; a life, in all essential things, parallel and concurrent with that of the tissues. For in the blood we may trace all those which we recognise as signs and parts of life in the solids; we watch its development, its growth, its maintenance by the assimilation of things unlike itself; we find it constituting an adapted purposive part of the organism; possessing organic structures; capable of disease and of recovery; prone to degeneration and to death. In all these things we have to study the life of the blood as we do that of the solid tissues; the life, not only of the structures of the blood, but of its liquid also; and as, in first development, the blood and tissues are made, of similar materials, in exact conformity with one another, so, through later life, the normal changes of each concur to maintain a like conformity and mutual adaptation. I cannot now dwell on these points;[1] but they will be frequently illustrated in the following lectures, and some of them at once, in what I have to say, of the precision of adjustment in which the 'right state' of the blood consists.

Notwithstanding its possession of the capacity of maintenance, the blood is subject to various diseases, in consequence of which the nutrition of one or more tissues is disordered. The researches of modern chemistry have detected some of these changes; finding excesses or deficiencies of some of the chief constituents of the blood, and detecting in it some of the materials introduced from without. But a far greater number of the morbid conditions of the blood consist in changes from

[1] They formed the subject of the course of Lectures delivered at the College in 1848, an abstract of part of which is given by Dr. Kirkes in his *Handbook of Physiology*, p. 63, *et seq.* 1st ed. and 74, 6th ed.

the discovery of which the acutest chemistry seems yet far distant, and for the illustration and discussion of which we cannot adopt the facts, though we may adopt the language and the analogies, of chemistry. It is in such diseases as these that we can best discern how nice is that refinement of mutual influence, how exact and constant that adaptation between the blood and tissues, on which health depends.

I know no instance so well adapted to illustrate this as the examples of symmetrical diseases. The uniform character of such diseases

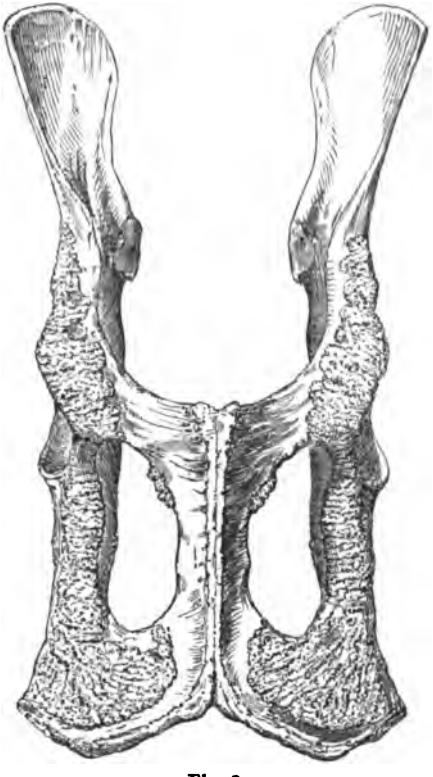

Fig. 2.

is, that a certain morbid change of structure on one side of the body is repeated in the exactly corresponding part on the other side. In the lion's pelvis, for example, which is sketched in the annexed diagram, Fig. 2, from a specimen (No. 3030) in the College Museum, multiform as the pattern is, in which the new bone, the product of some disease comparable with a human rheumatism, is deposited—a pattern more complex and irregular than the spots upon a mat—there is not one spot